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Preferences and Practices in High School Chemistry in Iowa

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A simple questionnaire was sent to Iowa's 474 teachers of high school chemistry in 1978 to determine textbook preference, degree of acceptance of self-paced instruction, popularity of the modular approach, and amount of time spent in the laboratory. The responses combined with information provided by the Department of Public Instruction revealed that the traditional approach to teaching chemistry appears to predominate in Iowa and that one particular textbook is the preference of a third of the teachers.
INDEX DESCRIPTORS: chemistry teaching, chemistry textbooks, science teaching.

For the past five years the Department of Chemistry at the University of Northern Iowa has been offering a required course for pre-service high school chemistry teachers called "Current Curricula in Chemistry." The course follows a general requirement for all science teaching majors called "Orientation to Science Teaching."

As the title of the course implies, it is intended to deal with current practice and movement in curricular development in one high school science course. Chemistry is one of several courses that have undergone changes in curricular philosophy in the past 15 years. At a time when "back to the basics" seems to be the trend in many schools, conspicuous changes are not evident in most of the recent editions of chemistry textbooks. In fact, there appears to be a return to the conventional or traditional approach in the scope and sequence of most of the books in use. "Current Curricula" may have implied more innovation a few years ago than it does today.

In order to find out what is truly current in the teaching of high school chemistry, we decided to go to the practitioners themselves to find out what their preferences and practices are. A simple questionnaire with no claim for statistical validity was developed to find out a few things about textbook preference (or at least usage), the degree of acceptance of self-paced instruction, the popularity of a modular approach, and the amount of time spent in the laboratory. Responses were gathered during the 1978-79 academic year.

THE POPULATION

According to information supplied by the Department of Public Instruction for 1978-79 there are 474 teachers in Iowa's secondary schools whose assignments include at least 1 chemistry course. Most of these teachers are involved in teaching other courses besides chemistry, mostly in science. The number of separate subjects taught ("preparations") ranges from 1 to 5, so it is not a simple matter to identify a "chemistry teacher" as a unique practitioner. Table 1 summarizes the various teaching assignments of these teachers — not in terms of number of classes taught but in terms of different subjects.

Table 1. *Number of Chemistry Teachers with Various Assignments 1978-79*

Subject(s) Taught	Number of Subjects Taught					Total Teachers of Each Subject
	One	Two	Three	Four	Five	
Chemistry	33	115	180	124	22	474 (100%)
and Physics	—	32	108	92	20	252 (53%)
Biology	—	35	58 (13)	27 (28)	1 (2)	162 (34%)
Phys. Sci.	—	9	2 (43)	1 (42)	0 (5)	94 (20%)
Other Sci.	—	16	6 (75)	1 (54)	1 (21)	174 (37%)
Math.	—	16	3 (23)	3 (9)	0	54 (11%)
Non-Sci.	—	7	3 (18)	(6)	0	34 (7%)

(Figures in parentheses are included in counts that precede them in the column.)

Almost 93% of all Iowa chemistry teachers have assignments that include other subjects; more than two-thirds teach at least 2 other subjects besides chemistry. More than half of them can be counted as "physics teachers"; however, 44% of the 252 chemistry-physics teachers teach 2 or 3 other subjects in addition to this pair. About 7% of all chemistry teachers have assignments that include courses outside of science or mathematics. Three-fourths of them teach courses outside the three standard high school courses of biology, chemistry, or physics.

These facts have obvious significance for the preparation of teachers of chemistry. For the purpose of this study, however, any inferences drawn from them that relate to curricular philosophy or teaching methods must be considered conjectural. Nevertheless, when one speaks of *chemistry* teachers and their preferences and practices, it is probably fair to assume that for most of them, decisions about chemistry teaching are not made as though chemistry were their only concern.

Table 2 shows, not surprisingly, that teachers of chemistry only are more likely to be found in high schools as opposed to junior-senior high schools. Even so, diversity of subjects taught is the rule rather than the exception among chemistry teachers in either type of school.

Table 2. *Number of Chemistry Teachers by School Type and Assignment Diversity*

School Type	Number of Preparations					Total Tchrs.
	One	Two	Three	Four	Five	
Public:						
High School	28	84	115	72	12	311
Jr.-Sr. High School	0	20	50	41	7	118
Parochial	6	11	15	10	3	45

Table 3 summarizes the various course offerings in chemistry as reported to the Department of Public Instruction (DPI) by the schools. The meaning of each different course title is not consistent among the schools, but the fact that 53 courses are second-level is significant, considering that only 24 courses offered are alternatives to the basic course.

Table 3. *Number of Different Chemistry Courses Offered in Iowa Schools**

Course Title	Number of Courses by School Type			Total
	High School	Jr.-Sr. H.S.	Parochial	
Chemistry I	245	105	32	382
CHEMS	52	8	11	71
CBA	2	0	0	2
PACE	4	0	0	4
Subtotal, Basic Courses	303	113	43	459
Chemistry II	25	4	2	31
Advanced Chemistry	17	2	3	22
Organic Chemistry	10	0	0	10
Biochemistry	1	0	0	1
Subtotal, Advanced Courses	53	6	5	64
Consumer Chemistry	3	1	0	4
Applied Chemistry	10	3	0	13
Other Chemistry	11	8	0	19
Subtotal, Alternative Courses	24	12	0	37
Chemistry-Indiv.	7	1	0	8
Chemistry-Proj.	1	1	0	2
Chemistry-Lab	3	0	0	3
Subtotal, Special Assignments	11	2	0	13
Number of Courses	391	133	48	572
Number of Teachers	311	118	45	474

*As reported to DPI by the schools

THE SAMPLE

In the spring of 1978 a brief questionnaire was sent to each of Iowa's chemistry teachers requesting information on several aspects of the chemistry courses they were teaching. Three additional follow-up mailings during the 1978-79 school year eventually elicited responses from about 73% of these teachers. The respondents constitute the sample. Preliminary tabulation of responses to the first mailing were in fair agreement with later responses, suggesting that extrapolation to *all* chemistry teachers in the state might have some validity. Table 4 may be compared with Table 1 to show some common characteristics between the sample and the population.

Table 4. *Number of Chemistry Teachers with Various Assignments**

Subject(s) Taught	Number of Subjects Taught					Total Teachers of Each Subject
	One	Two	Three	Four	Five	
Chemistry	25	80	131	96	15	347 (100 %)
and Physics	—	23	81	72	14	190 (54.8%)
and Biology	—	22	41 (9)	21 (18)	0 (0)	111 (32.0%)
and Phys. Sci.	—	6	0 (36)	0 (32)	0 (0)	74 (21.3%)
and Other Sci.	—	10	3 (56)	0 (49)	1 (21)	140 (40.3%)
and Math.	—	14	3 (13)	3 (8)	0 (0)	41 (11.8%)
and Non-Sci.	—	5	3 (14)	0 (6)	0 (0)	28 (8.1%)

*Sample only. (Figures in parentheses are included in counts that precede them in the column.)

THE FINDINGS

Assuming that the "curriculum" used in a chemistry course is generally dictated by the choice of textbook, the questionnaire requested such information for each course. The earliest responses revealed an obvious preference for one of 3 or 4 textbooks and provided a means of simplifying textbook identification in follow-up mailings. Table 5 lists the 11 most frequently named. The enrollment figures supplied by the respondents are useful for comparison but should not be considered highly accurate.

Table 5. *Textbooks Used in High School Chemistry in Iowa*

Textbook	Courses		Students	
	No.	%	No.	%
1. Metcalf, *et al, Modern Chemistry*	166	33.4	3,820	26.4
2. Smoot and Price, *Chemistry: A Modern Course*	69	13.8	2,297	15.9
3. Wengert, *Personalized Adventures in Chemical Education* (PACE)	39	7.8	1,232	8.5
*4. Parry, *et al, Chemistry: Experimental Foundations*	35	7.0	1,497	10.3
*5. O'Connor, *et al, Chemistry, Experiments and Principles*	27	5.4	920	6.4
*6. Cotton, *et al, Chemistry, an Investigative Approach*	25	5.0	722	5.0
7. Choppin, *et al, Chemistry*	19	3.8	614	4.2
8. Toon and Ellis, *Foundations of Chemistry*	19	3.8	776	5.4
9. Atkinson, *et al, Interdisciplinary Approaches to Chemistry* (IAC)	17	3.4	673	4.6
10. Harris and Greenstone, *Concepts in Chemistry*	12	2.4	406	2.8
11. Bolton, *et al, Action Chemistry*	10	2.0	419	2.9
Other	61	12.2	1,094	7.6
TOTALS	499	100.0	14,470	100.0
Distribution Among Multiple Course Offerings in Same School:				
Course A	407	81.6	12,644	87.4
Course B	88	17.6	1,747	12.1
Course C	4	0.8	79	0.5

*CHEM Study revisions.

There are only 2 textbooks that are used by more than 10% of all the students taking chemistry, and these 2 are used by about 42%. About one-third of all chemistry courses use the same book, *Modern Chemistry,* by Metcalf, *et al.* It outnumbers the next most popular text by more than 2 to 1 in terms of courses as well as numbers of students. Both are "modern," according to the titles. The popular *Modern Chemistry* has been around for a long time, pre-dating the federally funded curricula of the 1960's and always successfully coping with changes in curricular vogue. The most recent edition of the Teacher's Guide, for example, deals heavily with Piagetean concepts and the development of operational reasoning skills.

Wengert's PACE program at first glance appears to be third-ranked in popularity. Two points should be made, however — one, that this curriculum is used in less than half as many courses as Smoot and Price (which ranks second) and in about one-fifth as many courses as the first choice; two, that PACE is the only material listed designed specifically for self-paced instruction. According to the survey, self-paced instruction in chemistry is not common in Iowa, with 41 courses involving 1258 students in this mode. Some slight degree of self-pacing was reported by 17 other teachers using several other more conventional textbooks. Over all, only 8% of the teachers reported using any kind of self-paced instruction. In Table 3 it was noted that only 4 "PACE" courses were reported as such by the schools themselves.

There are three CHEM Study revisions in the list of Table 5, used by 87 schools and 3139 students. Taken together they account for almost 22% of the students and more than 17% of the courses, indicating that the current forms of the CHEM Study materials are second only to *Modern Chemistry* in popularity. Smoot and Price's *Chemistry, A Modern Course,* comes in as third rank then with 16%. There seems to be little doubt that CHEM Study made an impact on many textbooks, although the revisions have tended to "traditionalize" the original CHEM Study text. Referring again to Table 3, note that only 71 "CHEMS" courses were reported by the schools.

Most of the other textbooks in Table 5 enjoy about equal but limited popularity, with none of them used in more than 4% of the courses nor by more than 5-6% of the students. The "other" category includes 16 different textbooks, none of which is used in even 1% of the schools reporting. (Four schools were still using the original CHEMS text; one was still using the CBA text.)

Some of the courses included in Table 5 are second or third chemistry offerings in the same school. Only 4 responding schools have 3 separate chemistry courses whereas 85 schools offer 2 courses. One school that did not respond to the survey has four separate chemistry assignments listed by DPI. Twelve schools in the sample use a college-level textbook in a second "advanced" course; 3 offer organic chemistry and 5 offer qualitative analysis. Table 3 indicates that there are 64 courses offered that appear to go beyond the basic first-year course.

Table 3 also shows that there are 24 courses offered that are alternatives to the basic course. The most commonly used textbook in a second course, whether it be an alternative or an "advanced" course is *Interdisciplinary Approaches to Chemistry* (IAC), an innovative collection of modules that are essentially independent. In the survey sample, 11 schools that offer only 1 chemistry course are using IAC; 4 others are using it as a second course. One of the latter is using it as an "advanced" course for 12th graders. All of the schools offering 3 different courses are using IAC in one of them.

The next most popular textbook in a second course is *Action Chemistry,* used by 7 schools as an alternative to the basic course.

All of the teachers who responded indicated that some time was spent in laboratory work, ranging from 0% to 65% in conventional group instruction. Users of the PACE program indicated a range of 20-100% in the laboratory. These responses are not likely to represent the same thing across the board from teacher to teacher because of variation in the definition of laboratory time, but some qualitative comparisons may be valid using means. Table 6 compares the amount of "laboratory time" in the various courses included in the survey. The average appears to be greater in the second course (B) than in the first course (A).

Table 6. *Laboratory Time in High School Chemistry Courses*

	No. of Courses	Range (%)	Mean (%)
Course A*	296*	10-65*	26*
Course B	69	0-100	46
Course C	2	—	50
PACE	24	20-100	43

*Not including PACE

CONCLUSIONS

This limited survey seems to point out that Iowa chemistry teachers tend to be conventional, judging from the overwhelming popularity of 1 textbook that has withstood the test of time. CHEM Study apparently had some lasting impact on high school chemistry textbooks in general, but the popularity of the 3 revisions seems to imply that there is a fairly homogeneous attitude among teachers of chemistry that favors a conventional or traditional approach. There is certainly no homogeneity with regard to the amount of laboratory time used in chemistry courses, however.

An obvious conclusion that can be drawn from the survey and from the study of teaching assignments as reported to the DPI is that aspiring chemistry teachers will be more properly equipped for service if they prepare themselves in 2 areas outside of chemistry, preferably physics and 1 other science discipline.

Another suggestion that comes out of this survey is that teachers of chemistry should at least explore some less conventional approaches to the subject in order to seek improvements in teaching effectiveness and enrollments. An obvious place to start is the selection of the textbook.